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Decision-making skills as a mediator of the #Tamojunto school-based prevention program: Indirect effects for drug use and school violence of a cluster-randomized trial



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ARTICLE INFO	A B S T R A C T				
A R T I C L E I N F O Keywords: Prevention programs School-violence Drug use Mediation Decision-making skills	 Background: The aim of the present study was to evaluate a formal mediation analysis effect of the #Tamojunto program on adolescents' drug use and violent behavior in schools through decision-making skills using a potential outcomes approach. Methods: An in-cluster randomized controlled trial was conducted in 2014–2015 with 6691 7th- and 8th-grade students in 72 public schools in 6 Brazilian cities to evaluate the effects of the European drug prevention program Unplugged, called #Tamojunto in Brazil. Baseline data were collected prior to program implementation, and follow-up data were collected 9 and 21 months later. Mediation analysis using a potential outcomes approach, in which counterfactuals are modeled if positivity is met, was used to evaluate the indirect effects of the program #Tamojunto on the third-wave of drug use (alcohol, tobacco, marijuana, inhalants, and binge drinking) and school violence (bullying or physical, verbal and sexual aggression) assessment through decision-making skills. Results: When controlling for all covariates, the Total Natural Indirect Effect (TNIE) was significant only for past-year drug use (TNIE = 0.003, 95%CI = 0.001; 0.007). In the adjusted models, 37.5% of the effect of the intervention on drug use was mediated by decision-making skills. Conclusions: The #Tamojunto program changes decision-making skills but in the opposite direction proposed by the theoretical model of the program, suggesting that modifications are needed to produce the intended effect of the program. 				

1. Introduction

The European school drug prevention program Unplugged, called #Tamojunto in Brazil, is based on the Comprehensive Social Influence approach; it is expected to improve adolescents' personal and interpersonal skills to control social influences, through which adolescents develop erroneous perceptions of the frequency and acceptability of drug consumption (Giannotta et al., 2014). The short-term goal of this program was to reduce the number of adolescents who used alcohol and other drugs (Faggiano et al., 2008a). In European countries, a large multicenter randomized controlled trial (RCT) showed that Unplugged was effective in reducing drunkenness episodes and recent cigarette and cannabis smoking among adolescents (Faggiano et al., 2010, 2008b).

In Brazil, an RCT was conducted to evaluate the transcultural

adaptation of the Unplugged program (adapted and implemented by the Brazilian Ministry of Health) and showed that #Tamojunto increased first alcohol use and decreased first inhalant use in the intervention group compared to the control group at the 9-month (Sanchez et al., 2017) and 21-month follow-ups (Sanchez et al., 2018). Considering there is a well-known association between drug use and violence among adolescents (Ttofi et al., 2016; Weiner et al., 2005), as well as the positive findings on students' interpersonal relationships from the #Tamojunto pilot study (Medeiros et al., 2016), school violence was also evaluated as an outcome in the #Tamojunto RCT. The program was found to reduce only bullying victimization, particularly in girls aged 13–15 years at the 9-month follow-up time point, but the effect was not sustained at 21 months (Gusmões et al., 2018).

Considering these unexpected results, understanding the likely

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mechanisms underlying the success and failure of this program is needed to identify whether the prevention program affected the mediating variables that were targeted by the intervention as proposed in its logic model (Kreeft et al., 2009b; Vadrucci et al., 2016). Training in decision-making skills was expected to be one of the mediators of the causal process of the Unplugged program. Preventive interventions in this period of life can be extremely helpful, as adolescents are particularly vulnerable to risky decision-making associated with violent behaviors and drug use (Kelley et al., 2004), because the regions of their brains required for decision-making are still developing (Spear, 2018). Considering that early adolescents are in the middle of a maturational process related to improvements in many aspects of executive functioning (Christie and Viner, 2005; Steinberg, 2007), the logistic model of the program expects short-term changes in decision-making skills. According to problem behavior theory (Jessor and Jessor, 1977) by practicing self-control and creative thinking with structured problem-solving activities, the program aimed to help adolescents to better evaluate and react to environmental influences through the increase of decision-making skills (Vadrucci et al., 2016). The hypothesis was that decision-making skills would impact the intentions to use drugs increasing students' ability to make informed decisions about using drugs in the face of proximal risk factors such as life stressors and peer pressure (Sussman et al., 2004). Decision-making should work as a mediator of the intervention effects (Cuijpers, 2002; Griffin and Botvin, 2010; Onrust et al., 2016) through two paths: prevention program activities modifying the mediators (Chen, 1990) and the mediators affecting the outcome measurements (MacKinnon et al., 2002).

Decision-making is one of the most commonly applied elements in general skills training (Onrust et al., 2016) that is presented as a core element in most school-based prevention programs (Hecht et al., 2008; Hurry and McGurk, 1997; Rohrbach et al., 2010; Sloboda et al., 2009). A recent meta-analysis showed that the effectiveness of universal drug prevention programs was predicted by decision-making skills training (Onrust et al., 2016). Other social influence-based school prevention program studies have conducted mediation evaluations and showed positive findings (McNeal et al., 2004; Stephens et al., 2009). Despite the fact that decision-making skills are one of the core elements of the *Unplugged* program, the study that evaluated the short-term mediation factor did not evaluate the effect on decision-making skills as a mediator (Giannotta et al., 2014). In general, there is a lack of evaluations of mediation mechanisms, especially using new analytical paradigms in which results have causal interpretation (Liu and Flay, 2009).

We propose a mediation analysis using a potential outcomes approach, an epidemiological method recently developed in which counterfactuals are modeled if positivity is met. The potential outcomes method allows the decomposition of the total effect (i.e., the effect of #Tamojunto on adolescent drug use and on violent behavior), particularly when interactions and nonlinearities are present that can lead to inaccuracies in the estimates obtained from more traditional approaches. Moreover, unlike traditional statistical methods, the potential outcomes approach clarifies the likelihood that the assumption of no confounding by unmeasured variables is met, which is necessary for causal interpretation (VanderWeele, 2015). It is important to highlight that path a (i.e., effects of the exposure on the mediator) and path b (i.e., effect of mediator on outcome) do not need to be statistically significant in order to the indirect effect being statistically significant. This is because the indirect effect per se is given by a product between path a and path b (called "product method"), which may be also not asymptotically distributed and because of that it is commonly use of bias corrected bootstrapped confidence intervals to evaluate its statistically significance (VanderWeele, 2015; Vanderweele and Vansteelandt, 2009).

The aim of the present study was to evaluate the mediator effect of adolescents' decision-making skills from the #Tamojunto program on drug use and violent behavior in schools after 21 months. We hypothesized that decision-making skills would mediate the associations between the intervention and drug use and violence perpetration and that larger causal relationships would be observed.

2. Methods

2.1. Study design

The present study was based on a two-arm, three-wave school cluster randomized controlled trial in which schools were randomly assigned to either the intervention arm (#Tamojunto program) or to a control arm that received the usual education curriculum in Brazil (no prevention program); this study included adolescents in 72 public schools in 6 Brazilian cities (São Paulo, Distrito Federal, São Bernardo do Campo, Florianópolis, Fortaleza and Tubarão) in 4 Brazilian states.

Excel's macro [command RAND] was used to perform the randomization at the school level, and in the drawn school, all potential classrooms were invited to participate. Data were collected simultaneously in the control and intervention schools at three time points. Pretest data were collected in February 2014. The first follow-up assessment was carried out in November 2014, 9 months after baseline assessment and 6 months after the last session of the intervention. The second follow-up assessment was conducted 21 months after baseline and 18 months after the last session of intervention, in November 2015.

The RCT was registered at the Brazilian Ministry of Health Register of Clinical Trials (REBEC) under protocol number RBR-4mnv5g with a Pre-Registered Hypothesis and the protocol publicly available at this registry (http://www.ensaiosclinicos.gov.br/rg/?q=tamojunto). All procedures in the present study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The Universidade Federal de São Paulo Ethics Committee approved the protocol for human research (# 473.498). Consent to participate in the study was written and obtained from the schools' directors before randomization and from students, after randomization. All participants took part voluntarily after having given their free and informed consent based on the autonomy of adolescents guaranteed by the Brazilian Statute of the Child and Adolescent (Law No. 8069/1990). Moreover, parents were informed of the study by the directors and could recommend non-participation in data collection if they preferred. However, participation in the intervention was part of the school curriculum and was mandatory for all the students in the participating schools.

2.2. Population and sample size

Based on the sample size calculation (Lwanga and Lemeshow, 1991), for a given power of 80%, a significance level of 5% and a difference between groups of 1.5% (i.e., from 5% to 3.5%), the necessary sample size for each study arm was calculated to be 2835. To account for losses and for a high intraclass correlation, the sample was increased by 50% and had to include 4253 participants for each arm at a 1:1 ratio.

The target population was students attending 7th and 8th grade (12 to 13 years of age) in the geographical areas of the cities participating in the study. The school drawing occurred in each of the participating municipalities using the complete list of public middle schools in these locations as the database for randomization according the national registration list of schools from the Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP). Considering a 10% rate of school refusal, 38 schools were enrolled in each arm. A total of 72 schools accepted our invitation to participate in the study, as described in Fig. 1. Details on the study design and sampling methods have been previously presented (Sanchez et al., 2018; Valente et al., 2018).

2.3. Intervention

The Unplugged program was first designed by the European Drug



Fig. 1. Flow diagram for the randomized controlled trial.

Int* = Interaction.

Control Variables: Age, Sex, Baseline assessment and socio economic status.

Absent = absent from school at time of assessment.

Refusals = subjects who refused to participate in the assessment.

Valid = number of subjects cross-sectional.

Respondent = participants who assented to participate and provided data.

Addiction Prevention Trial (EU-DAP) group (Kreeft et al., 2009a) and consists of 12 classes of a social influence curriculum (4 one-hour classes on attitudes and knowledge of drugs, 4 classes on social and interpersonal skills, and 4 classes on personal skills), with an average class time of 50 min. The classes are delivered by class teachers trained and guided by the student and teacher manuals. Both manuals are openaccess and made available in several languages on the website www. eudap.net and major details regarding implementation and cultural adaptation might be found in details in (Sanchez et al., 2018, 2017).

The implementation and cultural adaptation of the program were the responsibility of the Brazilian Ministry of Health (BMH) team under the supervision of the European developers (in 2013). The English version of the *Unplugged* material was translated into Portuguese, retaining the original format and subject (educational strategies provided in 12 classes and 3 parent workshops) but with adapted activities. Nevertheless, the main changes were made to align the activities of the program with the Alcohol and Other Drugs Policy paradigm advocated by the Brazilian government (Brasil, 2015), changing the original perspective of the program, which is alcohol abstinence, to a harm reduction paradigm focused on the prevention of episodes of intoxication. More details about the cultural adaptation process were described previously (Madruga and Quirino, 2018).

2.4. Instrument and variables

The instrument used for data collection was developed and tested by the EU-DAP and used in previous studies of the effectiveness of *Unplugged* (Faggiano et al., 2008b). In Brazil, we used a translated and adapted version of the EU-DAP questionnaire in Portuguese (Cainelli de Oliveira Prado et al., 2016) that had some questions replaced with items from two questionnaires that were widely used in several studies among Brazilian students: a questionnaire by the World Health Organization for drug surveys at schools that was adapted by the Brazilian Center for Psychotropic Drug Information (Carlini et al., 2010) and a questionnaire by the Brazilian National Survey of School Health (PENSE) that was used by the BMH (IBGE, 2013). The following two outcomes were analyzed after 21 months of follow-up: 1) polydrug use, which was the simple sum of past-year use (yes = 1 vs. no = 0) of alcohol (including binge drinking or the consumption of five or more alcoholic drinks on a single occasion), to-bacco, marijuana, and inhalants, ranging then from 0 to 5; and 2) school-violence perpetration, which was the simple sum of past-month episodes (yes = 1 vs. no = 0) of 4 types of school-violence perpetration, bullying and verbal, physical and sexual aggression, ranging from 0 to 4.

The confounder variables were sex, age and socioeconomic class (SES) assessed using the Associação Brasileira de Empresas de Pesquisas (ABEP) scale (ABEP, 2012). To evaluate decision-making skills, we used the 9-item (agree or disagree) scale developed by EU-DAP (Giannotta et al., 2014) with the following questions: "When I have decided to do something, I always carry it through"; "I often make up my mind without thinking of the consequences"; "Sometimes I decide on something "off the top of my head"; "I seldom decide to do something that I later regret"; "When I get an idea I often make a decision without thinking"; "Sometimes I change my mind about something several times a day"; "When I decide on something it doesn't matter what my friends think" and "When I decide on something it doesn't matter what my parents think". We create parceling scores of the 8-item from the scale, where the higher the score the lower the decision making skill, with lower scores representing higher decision making skills. The parceling procedure was adopted to reduce the number of comparisons across the mediators (consequently generating a more parsimonious model). The summing variables for drug use, violence and decisionmaking are often referred to as parcels and are based on the Aggregation Principle (Matsunaga, 2008; Nunnally, 1978; Rushton et al., 1983) and on the Law of Large Numbers (Little et al., 2002; Matsunaga, 2008). A given parcel will have a larger proportion of true-score variance to unique variance than any item used to build it (Little et al., 2013). As a consequence, the higher the number of items summed, the higher the proportion of true-score variance. Major details about the measurement model underlying school-violence and decision-making skills can be found in Supplemental Material, where an item-level analysis was conducted using confirmatory factor analysis.

To pair (link) the questionnaires of each subject at the three data collection time points (baseline and the two follow-up time points), students filled in a secret code created from their personal information. These codes protected the participants, offering anonymity and confidentiality, and at the same time allowed researchers to link the individual questionnaires collected at the different time points of the study (Galanti et al., 2007). The secret codes were matched using the Levenshtein algorithm, which identifies similarities among a set of characteristics. School and class codes were included in the matching process (Levenshtein, 1965).

2.5. Statistical analysis

We used the potential outcomes method proposed previously (Robins and Greenland, 1992) and further elaborated by Preacher (Preacher et al., 2007) to evaluate the indirect effects of the #Tamojunto prevention program on drug use and violence in adolescence through decision-making skills. In traditional mediation models, the indirect effect is a product of two slopes: one from exposure to the mediator (a) and one from the mediator to the outcome (b). In addition, the potential outcomes method decomposes indirect and direct effects allowing interaction between exposure and mediator in predicting the outcome (Judd and Kenny, 1981; Preacher et al., 2007). For details of the causal effect formulas see Vanderweele and Pearl (Pearl, 2001; Vanderweele and Vansteelandt, 2009).

In this manuscript, we focused on the total natural indirect effect (TNIE) and pure natural direct effect (PNDE), which were used to calculate the proportion of the mediated effect as follows: TNIE/ (TNIE + PNDE). PNDE is the average difference in drug use if everyone

was randomized to the control group compared to the intervention group at the population level, but decision-making took the value it would have had if everyone was in the intervention group. TNIE is the average difference in drug use if decision-making took the value it would have taken at the population level if everyone was randomized to the control group compared to if everyone was allocated to the control group, with the direct effect estimated as if everyone was in the control group (Vanderweele and Vansteelandt, 2009). Because of the cluster structure (i.e., children nested in 72 schools), the standard errors and chi-square test of the model fit were adjusted for the children's nonindependence. To that aim, we used the COMPLEX option in Mplus, as proposed by Asparouhov (2006, 2005), by specifying *schools* as a cluster variable.

To deal with missing data related to adolescent drug use (followup), violent episodes (baseline e follow-up), and decision-making skills (baseline e follow-up), we used multiple imputation through a sequential imputation approach (Muthén and Muthén, 2010). The following variables were used in the unrestricted model: group, school, gender, age, past-year drug use at baseline (alcohol, binge drinking, cigarettes, inhalants, marijuana), and ABEP classification (baseline). Five imputed data sets were generated, and the estimates shown in Table 2 are the pooled estimates of TNIE and PNDE.

Lastly, sensitivity analyses were performed based on the works of Imai et al. (2010b, 2010a) to understand the possible violations of the assumption of no confounding by unmeasured confounders in the mediator-outcome association. This analysis allows us to answer questions about how large the indirect effect needs to be for the confidence intervals to not include zero, which allows a certain degree of mediator-outcome confounding. In this approach, different values of the residual covariance between the mediator and the outcome are fixed, but the outcome is not regressed on the exposure (Muthén and Muthén, 2017).

All the analysis were ran in Mplus 8.2 (Muthén and Muthén, 2010), being the adopted significance level of 5%.

3. Results

Table 1 presents the characteristics of the students participating in the study (N = 6391). Both groups (i.e., the intervention and control groups) were homogenous with respect to sex, age and socioeconomic classification by the ABEP scale at baseline.

Fig. 1 shows the conceptual mediation model with an interaction between the exposure and mediator. The main routes (paths a, b and c') are equivalent to the ones represented in traditional mediation analyses. The additional effects present in the potential outcomes model account for an exposure-mediator interaction, which showed to be significant. The effect of the mediator was statistically significant for both outcomes: drug use ($\beta = 0.120$, 95%CI = 0.076; 0.164), and violent behavior ($\beta = 0.062$, 95%CI = 0.023; 0.101).

Table 2 shows the direct and indirect effects of randomization group on drug use and episodes of violence through decision-making skills. Both PNDE was not statistically significant. When controlling for all covariates, the TNIE was significant for past-year drug use (TNIE = 0.003, 95%CI = 0.001; 0.007), however it was not significant for school-violence (TNIE = 0.005, 95%CI = -0.001; 0.010). In the adjusted models, 37.5% of the effect of the intervention on drug use was mediated by decision-making skills (Table 2).

The sensitivity analyses showed that we would need a small effect (rho > 0.1) of unmeasured potential confounders on the mediator and outcome (drug use) variables concomitantly to completely explain away the indirect effect observed (Fig. 3). For the school violence outcome, once again, a small effect (rho > -0.05) would be enough to bring the confidence interval of the indirect effect to zero (Fig. 4). In other words, the conclusion that the indirect effects is positive (for drugs) and negative (for violence) and significant is in question. It was found that the positive indirect effect was significantly different from zero at residual correlation values less than 0.1 for drug use to have

Table 1

Outcomes, mediator and sociodemographic characteristics of the participating students in the evaluation of the #Tamojunto school-based program for drug use prevention (N = 6.391).

	Total (N = 6.391)		Group				
			Intervention Arm (N = 3.148)		Control Arm (N = 3.243)		
	N	% or mean + SD	Ν	% or mean + SD	N	% or mean + SD	
Gender							
Boys	3,130	48.98	1.600	49.34	1.530	48.60	
Girls	3,261	51.02	1.643	50.66	1.618	51.40	
Age Distribution							
	6391	12.62 ± 0.82		12.64 ± 0.83		12.60 ± 0.82	
SES ^a							
A (35-42)	244	3.78	125	3.86	119	3.79	
B (23-34)	2467	36.64	1.261	38.98	1.206	38.40	
C (14-22)	3343	53.98	1.704	52.67	1,639	52.18	
DE (0-13)	322	5.6	145	4.48	177	5.64	
Baseline Past-Year Drug Use ^b							
	6.191	0.62 ± 0.01	3.128	0.63 ± 1.02	3.063	0.62 ± 0.99	
Baseline School-Violence ^c							
	6.166	0.40 ± 0.79	3.131	0.41 ± 0.82	3.035	0.37 ± 0.76	
Baseline Decision-Making Skills							
	5.361	3.39 ± 1.96	2.709	3.36 ± 2.01	2.652	3.40 ± 1.89	
9 months Follow-up Decision-Making Skills							
	3.786	3.73 ± 1.87	1.799	3.80 ± 1.88	1.987	3.67 ± 1.86	
21 months Follow-up Past-Year Drug Use							
	3.537	0.98 ± 1.22	1.730	1.00 ± 1.23	1.807	0.96 ± 1.20	
21 months Follow-up School-Violence	2 5 6 0		1 7 40	0.50 . 0.00	1 017	0.47 . 0.00	
	3.560	0.50 ± 0.85	1./43	0.52 ± 0.88	1.81/	0.47 ± 0.82	

^a socioeconomic classification according to the ABEP.

^b number of drugs used in the past 12 months.

^c number of episodes of school violence in the past 30 days.

positive indirect effects and higher than -0.05 to generate negative and significant effects on because the lower confidences limits do not crosses the y = 0 further than these values. (Fig. 4).

Regarding the results related to the fidelity of the implemented intervention, a total of 87% of the schools completed the 12 program lessons. The other 13% ended the program between lessons 4 and 11 for two main reasons: the teachers went on medical leave or were not comfortable implementing the program. 72% of classes taught were given in full, with the execution of all activities provided in the protocol.

4. Discussion

The present study used a mediation analysis with a potential outcomes approach to test the hypothesis that the #Tamojunto prevention program changed decision-making skills at 9 months, which in turn would reduce drug use and violent behavior after 21 months. The evidence suggests that #Tamojunto didn't affected directly the outcomes, once the PNDE was not statistically significant (path C). The program act indirectly decreasing decision-making skills and then these effects increase drug use, since we found a significant indirect effect (TNIE) from #Tamojunto program on drug use though adolescents' decision-making skills (path A*B). This paper also shows that there is a significant association between decrease in decision-making skills and increase in drug use and violent behavior (path B).

Our results regarding the mediation analysis, contradicts the expected results proposed by the program's theoretical model which indicated that #Tamojunto might operate on outcomes via increasing in decision-making skills (Faggiano et al., 2010; Pedroso et al., 2015). This finding also contradicts the results found in previous studies (McNeal et al., 2004; Stephens et al., 2009) which showed that prevention programs can help adolescents learn to make decisions about their behavior by engaging them in the cognitive process of decision-making (Sussman et al., 2004). So, it is important to highlight that the interventions does not always impact the mediators as expected (in the direction and also in terms of magnitude) carrying consequences to programs outcomes.

Considering that the decision-making process helped adolescents

Table 2

Counterfactual-derived direct and indirect effects, regression coefficients, and confidence intervals based on multiple imputation analysis.

	Non-adjusted			Adjusted with covariates		
	Estimate	95%CI	p-value	Estimate	95%CI	p-value
Past-Year Drug Use ^a						
Total Natural Indirect Effect (TNIE)	0.019	[-0.006; 0.045]	0.132	0.003	[0.000; 0.007]	0.037
Pure Natural Direct Effect (PNDE)	0.015	[-0.125; 0.154]	0.835	0.005	[-0.042; 0.052]	0.834
Proportion Mediated	55.88%			37.5%		
School-Violence ^b						
Total Natural Indirect Effect (TNIE)	0.006	[-0.002; 0.015]	0.161	0.005	[-0.001; 0.010]	0.127
Pure Natural Direct Effect (PNDE)	0.035	[-0.029; 0.098]	0.286	0.008	[-0.102; 0.118]	0.892
Proportion Mediated	14,63%			41.67%		

^a number of drugs used in the past 12 months.

^b number of episodes of school violence in the past 30 days.

ponder the information about drug use (Sussman et al., 2004) and evaluate the consequence involved in the decision (Kreeft et al., 2009a), this unexpected effect of the program on the mediator could be hypothesized to result from the change in the theoretical model of the program. The cultural adaptation of the program made important changes in the "Alcohol, Risk and Protection" lesson. Phrases that emphasized the importance of abstaining from alcohol use were excluded, and reflexive questions about how to avoid alcohol abuse were added (Madruga and Quirino, 2018; Sanchez et al., 2017); this change could have reduced the adolescents' risk perception, which would be associated with the decrease in decision-making skills that may have led to a perception of greater safety of drug use. Another possible explanation for this result is that students' previous knowledge and beliefs about drug use impact their decision-making skills in deciding to use drugs, as found in a previous study (Sanchez et al., 2019). These results have a significant impact on the prevention program literature since they provide evidence of the importance of the program content on drug use and the adolescents' previous knowledge and beliefs and not only on the mechanism and mediators involved.

Despite these findings for mediation, this paper shows that there is a clear association between decrease in decision-making skills and increase in drug use and violent behavior independent of the group allocation. As we can see in Fig. 2 we found that the path B (mediator effect on outcomes) was statistically significant. These results show that investigation in decision-making skills as mediator is valuable for reducing drug use and violent behavior, as there is a clear association, corroborating the international guidelines [7]. This findings also corroborated the idea that the components of the drug use prevention programs can also improve school violence, reinforcing that training in decision-making skills can affect both outcomes (drug use and violence) (Botvin et al., 2006; Cox et al., 2016; Fagan and Catalano, 2013). One possible explanation for this mediation effect is that violence is associated with impulsive behavior (Jiménez-Barbero et al., 2016) and the decision-making process can help to deal with impulsiveness. By practicing communication skills, empathy and interpersonal relationships (Vadrucci et al., 2016), the program can also help people avoid violent behaviors.

From the sensitivity analysis, we might note that there were unmeasured variables that might have influenced both the mediator and the outcomes with correlations higher than 0.1 for drug use and -0.15 for violence. Predictors of the mediator and outcomes beyond those controlled for could render the observed indirect effect nonsignificant, such as parenting styles (Wolff and Crockett, 2011) and household composition (Hecht et al., 2008). Therefore, the conclusion that the indirect effects are statistically significant is questionable.

A limitation of this study was the excessive amount of missing data, especially from follow-up measures. However, it is worth noting that attrition is an expected limitation in longitudinal studies, especially among those with long follow-up (Ariza et al., 2013; Newton et al., 2010; Shope et al., 1992). Despite the fact that imputation processes offer excellent solutions to these missing data problems by estimating the missing values (Dong and Peng, 2013), missing data will always be



Fig. 2. Conceptual model of the mediation tested. Vertical axis: Total Natural Indirect Effect of Group on Drugs. Horizontal axis: RHO

a limitation when interpreting trial results, once the missing data will result in loss of statistical power. Considering that, this trial results should always be interpreted with caution (Jakobsen et al., 2017).

5. Conclusion

In conclusion, this study showed that decrease in decision-making skills due to the #Tamojunto program potentially mediated the increase in drug use in schools through 21 months. These results suggest this program changes decision-making skills but in the opposite direction proposed by the theoretical model of the program. The inability of the program to increase the decision-making skills mediator as expected may be partially responsible for the #Tamojunto negative outcomes. Lack on decision-making skills seem to be a potential risk factor for drug use and violent behavior, suggesting that drug prevention programs with decision-making skill components can also act in violent behaviors. The lessons of the program aimed at affecting decisionmaking skills should be changed.

Contributors

The submitted manuscript has been read and approved by all authors. All authors acknowledge that they have exercised due care in ensuring the integrity of the work. JYV was responsible for drafting the article and literature review; wrote introduction, results and discussion of the manuscript. HCM performed the analysis and interpretation. ZMS designed the study, wrote the grant protocol and was responsible for the final approval of the version to be published.

The authors declare that has listed everyone who contributed significantly to the work.

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Clinical trial registration

Brazilian Register of Clinical Trials - REBEC, of the Brazilian Federal Government, is #RBR 4mnv5g.

Declaration of Competing Interest

The authors declare none conflict of interest.

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Fig. 3. Sensitivity analysis of Total Natural Indirect Effect (Group to Drugs). Mean of the Total Natural Indirect Effect (red); 95% confidence interval for the Total Natural Indirect Effect (blue). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article). Vertical axis: Total Natural Indirect Effect of Group on Violence. Horizontal axis: RHO.



Fig. 4. Sensitivity analysis of Total Natural Indirect Effect (Group to Violence). Mean of the Total Natural Indirect Effect (red); 95% confidence interval for the Total Natural Indirect Effect (blue). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2019. 107718.

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